CLAIMS

We claim:

1. A method for determining a submarine geographic position, the method comprising the steps of:

   a) launching a radio navigation-enabled buoy and recording a launch time and a DRNS geographic position estimate of said buoy, wherein said DRNS geographic position estimate is determined by a DRNS;

   b) recording a buoy breach time and searching for radio navigation signals of said buoy, wherein said buoy breach time is subsequent to said launch time;

   c) recording a radio navigation position acquisition time and an initial radio navigation position of said buoy, wherein said ~~subsequent~~ acquisition time is subsequent to said buoy breach time;

   d) recording a subsequent radio navigation position of said buoy and a subsequent time, wherein said subsequent time is subsequent to said radio navigation position acquisition time;

   e) determining a DRNS correction factor using a DRNS position error, a buoy drift, the recorded radio navigation positions of said buoy ~~position data~~ and DRNS position data of said buoy;

   f) estimating said submarine geographic position using said DRNS correction factor and said DRNS geographic position estimate.

2. The method of Claim 1, wherein said radio navigation-enabled buoy comprises a GPS-enabled buoy.

3. The method of Claim 1, wherein said DRNS position error is determined by extrapolating a radio navigation/drift estimated geographic position of said radio navigation-enabled buoy at said buoy breach time using a radio navigation/drift position and said buoy drift and comparing said radio navigation/drift estimated geographic position of said radio navigation-enabled buoy at said buoy launch time to a launch time of said DRNS geographic position estimate of said submarine at said buoy launch time.

4. The method of Claim 1, wherein said DRNS is an INS.

5. The method of Claim 1, wherein said determining a DRNS correction factor ~~using DRNS position error, buoy drift, radio navigation position data and DRNS position data~~ comprises the following sub-steps:

i) extrapolating a radio navigation/drift estimated geographic position of said radio navigation-enabled buoy at said buoy breach time using said recorded radio navigation positions ~~data~~ and said buoy drift;

ii) comparing said radio navigation/drift estimated geographic position of said radio navigation-enabled buoy at said buoy breach time to a DRNS estimated geographic position of said submarine at said buoy launch time;

iii) determining said DRNS correction factor from said DRNS position error.

6. The method of Claim 5, wherein said extrapolating a radio navigation/drift estimated geographic position of said radio navigation-enabled buoy at said buoy breach time comprises the following sub-steps:

(1) determining said buoy drift by comparing said initial radio navigation position data to said subsequent radio navigation position and said radio navigation position acquisition time to said subsequent time;

(2) extrapolating said paid radio navigation/drift estimated geographic position of said radio navigation-enabled buoy at said buoy breach time using said recorded radio navigation positions ~~data~~ and said buoy drift.

7. The method of Claim 5, wherein said extrapolating a radio navigation/drift estimated geographic position of said radio navigation-enabled buoy at said buoy breach time by the following sub-steps:

(1) determining a latitude displacement and a longitude displacement by multiplying a latitude drift velocity by an elapsed time and a longitude drift velocity by said elapsed time, wherein said elapsed time equals a first event time subtracted from a second event time;

(2) subtracting said latitude displacement and said longitude displacement to a navigation position of said paid buoy associated with said second event time.

8. The method of Claim 7, wherein said first event time is said buoy breach time, and wherein said second event time is said radio navigation position acquisition time, and wherein said second event time is subsequent to said first event time.

9. The method of Claim 1, wherein said buoy drift is represented by latitude/longitude displacement over time.

10. The method of Claim 1, wherein said method is performed by a processing means.

11. The method of Claim 10, wherein said processing means includes a submarine navigation computer.

12. The method of Claim 10, wherein said processing means includes a buoy computer and a navigation computer.

13. A submarine launched radio navigation buoy system, comprising:

a) a submarine launched radio navigation buoy, capable of:

i) launching from a submerged submarine;

ii) obtaining a plurality of radio navigation positions of said buoy from radio navigation RF signals and a plurality of corresponding event times;

iii) transmitting said plurality of corresponding event times and said plurality of radio navigation positions;

b) a processing means, operatively coupled to said submarine launched radio navigation buoy, capable of:

i) receiving said plurality of corresponding event times and said plurality of radio navigation positions of said buoy;

ii) determining a DRNS correction factor using a DRNS position error, a buoy drift, said radio navigation positions ~~position data~~ and DRNS position data of said buoy;

iii) estimating a submarine geographic position using said DRNS correction factor and a DRNS geographic position of said buoy.

14. The submarine launched radio navigation buoy system of Claim 13, wherein said submarine launched radio navigation buoy is a GPS-enabled buoy.

15. The submarine launched radio navigation buoy system of Claim 13, wherein ~~said processing means determines~~ said DRNS position error is determined by extrapolating a radio navigation/drift estimated geographic position of said radio navigation-enabled buoy at said buoy breach time using a radio navigation/drift position of said buoy and said buoy drift and comparing said radio navigation/drift estimated geographic position of said radio navigation-enabled buoy at said buoy breach time to a DRNS estimated geographic position of said submarine at said buoy launch time.

16. The submarine launched radio navigation buoy system of Claim 13, wherein said processing means determines said DRNS correction factor ~~using DRNS position error, buoy drift, radio navigation position data and DRNS position data~~ comprises the following sub-steps:

i) extrapolating a radio navigation/drift estimated geographic position of said radio navigation-enabled buoy at said buoy breach time using said radio navigation positions ~~data~~ and said buoy drift;

ii) comparing said radio navigation/drift estimated geographic position of said radio navigation-enabled buoy at said buoy breach time to a DRNS estimated geographic position of said submarine at said buoy launch time;

iii) determining said DRNS correction factor from said DRNS position error.

17. The submarine launched radio navigation buoy system of Claim 16, wherein said processing means extrapolates a radio navigation/drift estimated geographic position of said radio navigation-enabled buoy at said buoy breach time comprises the following sub-steps:

(1) determining said buoy drift by comparing said initial radio navigation position data to said subsequent radio navigation position and said radio navigation position acquisition time to said subsequent time;

(2) extrapolating a radio navigation/drift estimated geographic position of said radio navigation-enabled buoy at said buoy breach time using radio navigation position data and said buoy drift.

18. The submarine launched radio navigation buoy system of Claim 16, wherein said processing means extrapolates said radio navigation/drift estimated geographic position of said radio navigation-enabled buoy at said buoy breach time by the following sub-steps:

(1) determining a latitude displacement and a longitude displacement by multiplying a latitude drift velocity by an elapsed time and a longitude drift velocity by said elapsed time, wherein said elapsed time equals a first event time subtracted from a second event time;

(2) subtracting said latitude displacement and said longitude displacement to a navigation position associated with said second event time.

19. A submarine launched radio navigation buoy system, comprising:

a) means for launching a radio navigation-enabled buoy;

b) means for recording a launch time, a DRNS geographic position estimate of said buoy, a buoy breach time, a radio navigation position acquisition time and a subsequent time, wherein said subsequent time is subsequent to said radio navigation position acquisition time, which is subsequent to said buoy breach time, which is subsequent to said launch time;

c) means for searching for and receiving radio navigation signals of said buoy;

d) means for recording an initial radio navigation position of said buoy and a subsequent radio navigation position of said buoy;

e) means for determining a DRNS correction factor using a DRNS position error, a buoy drift, the recorded radio navigation positions of said buoy ~~position data~~ and DRNS position data of said buoy;

f) means for estimating said submarine geographic position using said DRNS correction factor and a DRNS geographic position of said buoy.

20. A method for determining a submarine geographic position, the method comprising the steps of:

a) launching a radio navigation-enabled buoy and recording a launch time and a DRNS geographic position estimate of said buoy, wherein said DRNS geographic position estimate is determined by a DRNS;

b) recording a buoy breach time and searching for radio navigation signals of said buoy, wherein said buoy breach time is subsequent to said launch time;

c) recording a radio navigation position acquisition time and an initial radio navigation position of said buoy, wherein said ~~subsequent~~ acquisition time is subsequent to said buoy breach time;

d) determining a DRNS correction factor using a DRNS position error, a buoy drift, radio navigation position ~~data~~ and DRNS position data of said buoy, wherein said buoy drift is received from a DRNS associated with said radio navigation-enabled buoy; said recorded initial

e) estimating said submarine geographic position using said DRNS correction factor and said DRNS geographic position estimate.

21. A method for determining a submarine geographic position, the method comprising the steps of:

a) launching a radio navigation-enabled buoy and recording a launch time and a DRNS geographic position estimate of said buoy, wherein said DRNS geographic position estimate is determined by a DRNS;

b) recording a buoy breach time and searching for radio navigation signals of said buoy, wherein said buoy breach time is subsequent to said launch time;

c) recording a radio navigation position acquisition time and an initial radio navigation position of said buoy, wherein said ~~subsequent~~ acquisition time is subsequent to said buoy breach time;

d) determining a DRNS correction factor using a DRNS position error, a buoy drift, radio navigation position ~~data~~ and DRNS position data of said buoy, wherein said buoy drift is received from a sonar system capable of tracking said radio navigation-enabled buoy; said recorded initial

e) estimating said submarine geographic position using said DRNS correction factor and said DRNS geographic position estimate.